DEVELOPMENT OF CONTROLLER SOFTWARE SYSTEM FOR CAM MANUFACTURING MACHINE

MOGAN A/L ARASAPPAN

Report submitted in partial fulfillment of the
requirements for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2009

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature:
Name of Supervisor: EN. MOHD RUZAIMI BIN MAT REJAB
Position: LECTURER OF FACULTY OF MECHANICAL ENGINEERING
Date: 23/11/2009

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature:
Name: MOGAN A/L ARASAPPAN
ID Number: MA06043
Date: 23/11/2009

Dedicated to my beloved parents,

brothers and sister

ACKNOWLEDGEMENTS

I would like to express my sincerely gratitude to my supervisor, EN. MOHD. RUZAIMI BIN MAT REJAB, for constant guidance and providing useful information for me on my research from the beginning. I also would like to thank him for spending most of his precious time to help me with correcting my errors and all the help he has offered to finish this thesis.

My sincere thanks to ASSOC. PROF. DR. WAN AZHAR BIN WAN YUSOFF for his supports and provides me essential information on completing the program of this research. I also would like to thank him for allowing me to refer to his previous works and studies about program to develop cam profile.

Many special thanks go to I would also like to thank to all my course-mates and staffs of the Mechanical Engineering Department, UMP, who helped me in many ways and made my stay at UMP pleasant and unforgettable.

I acknowledge my sincere indebtedness and gratitude to my parents, MR. ARASAPPAN A/L SINNATHAMBY and MDM. AMMRATHAN A/P MARIMUTHU for their love, dream and sacrifice throughout my life. They were always stood by me and help me to motivate myself to overcome any obstacles. Lastly, I would like to thank my elder brother, YOGESVARAN A/L ARASAPPAN, my elder sister, SARASVATHY DEVI A/P ARASAPPAN and my younger brother, TIRUPPATHY A/L ARASAPPAN for their continuous supports and trusts.

ABSTRACT

This thesis is about developing controller software system for cam manufacturing machine by using cam parametric equations as a guide. Cam development is based on the cam shapes, follower types, and also the applications. Performance of a cam profile affects the speed of the system and the higher the speed, the system will experience more vibrations which lead to defectiveness of the system. These vibrations also may occur due to sudden acceleration of the cam surface once they were produced with unsmooth surface. In order to produce highly performance of cam, it has to have a smoothest surface of contact with the follower. The objective of this project is divided to two most important criteria which to derive a parametric equation system for both x and y axis from a relative cam parametric equation of motion and also to simulate a cam profile using parametric equation of motion by programming methods. The results of this project are from both graphical and programming methods and the results of each cam motions will be discussed. Finally, for conclusion and recommendation of this project, we will conclude the results and whether the objective of this project is achieved and we will also recommend little recommendation on how to improve the results obtain for further research to come.

ABSTRAK

Tesis ini adalah mengenai pengembangan sistem perisian pengontrol mesin produksi cam dengan menggunakan persamaan cam parametrik sebagai panduan. Pembinaan cam adalah berdasarkan kepada bentuk cam, jenis pengikut, dan juga aplikasi. Kelancaran profil cam mempengaruhi kelajuan sistem dan pada kelajuan yang lebih tinggi, sistem akan mengalami lebih banyak getaran yang menyebabkan kecacatan kepada sistem. Getaran ini juga boleh berlaku kerana percepatan permukaan cam secara tiba-tiba dan akan terhasil dengan permukaan yang tidak sempurna. Untuk menghasilkan kelancaran kualiti, cam itu harus mempunyai permukaan licin yang bertemu dengan pengikut. Objektif dari projek ini dibagi kepada dua kriteria yang paling penting untuk memperoleh sistem persamaan parametrik untuk kedua-dua paksi x dan y dari persamaan parametrik cam relatif gerak dan juga untuk mensimulasikan profil cam menggunakan persamaan parametrik gerak mengikut kaedah pengaturcaraan. Keputusan daripada projek ini adalah daripada kaedah grafik dan pengaturcaraan dan hasil dari keputusan masing-masing, gerakan cam akan dibahas. Akhirnya, kesimpulan dan cadangan untuk projek ini, kami akan menyimpulkan keputusan dan menyinpulkan tujuan dari projek ini sudah tercapai dan kami juga akan mengesyorkan sedikit cadangan mengenai bagaimana memperbaiki memperoleh hasil untuk kajian lebih lanjut yang seterusnya.

TABLE OF CONTENTS

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

β	Rotation angle of cam during the rise or fall interval under consideration (deg)
θ	Cam rotation angle measured against the direction of cam rotation from the home position
π	Pi
ω	Speed of the cam (degrees per time)
ϕ	Angle into rise or fall interval (deg)
a	Instantaneous follower acceleration
a	Constant variables
b	Constant variables
Cx	x coordinate of cutter center
Cx'	Differential x coordinate of cutter center
Cy	y coordinate of cutter center
Cy'	Differential y coordinate of cutter center
H	Total follower displacement during the rise or fall interval under consideration
ΔR	Instantaneous follower displacement
v	Instantaneous follower velocity

LIST OF ABBREVIATIONS

MEMS	Micro-Electromechanical Systems
CAD	Computer Aided-Design
CAM	Computer Aided-Manufacturing
RDR	rise-dwell-rise
DRFD	dwell-rise-fall-dwell
RFR	rise-fall-rise

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION OF CAM

A cam is generally known as an element of the cam-follower mechanical system that reciprocates (move back and forth) when direct contact with another element known as the follower thus creates a prescribed motion. Nevertheless, cam is properly design and manufacture for variety of applications, especially in requirement for high speed operation that enhances the accuracy, precision and repeatability.

Cam can be found in almost all mechanical devices and machines which can be seen in domestic industries of cam-follower machineries. In yearly year, the genius of Leonardo da Vinci was able to produce a modern design cam which applied to a machine for pumping water. This technically inspires much new application using the same concept. The obvious prove can be seen in oil pump at oil rig refinery that been used by many largest oil company nowadays.

Even so, the application of cam-follower mechanism system are however evolves into more convenient cam-driven machines such as automobile internal combustion engines, transportation equipment, and most recently the Micro-Electromechanical Systems (MEMS).

These applications are basically based on simple cam profile motion, where it consist series of events which are rise, dwell and return. Rise is a motion when the follower starts to move away from cam center, dwell is a motion where the follower is at rest, and return is when the motion of the follower moving towards closer to the cam center.

1.2 PROJECT BACKGROUND

The development of cam software system for computer resources are widely used in today mechanical equipment application and has contributed to understanding the cam-follower system complete design. Most manufacturer of industrial machinery has developed proprietary software packages for their specific needs. This project co-insists of developing a controller software system where it has high potential to be used for any cam manufacturing machine and reduce time consumed for a cam to be manufacture if compared to other cam designing software such as Computer Aided-Design (CAD) or Computer Aided-Manufacturing (CAM).

1.3 PROBLEM STATEMENT

Cam mechanism system is developed by combining two mutually related elements which is the cam and follower. Cam development is based on the cam shapes, follower types, and also the applications. Cam shapes determine how fast or slow do the speed the follower will achieve and does the performance of cam-follower system satisfied with the application. Performance of a cam-follower system affects the speed of the system and the higher the speed, the system will experience more vibrations which lead to defectiveness of the system. These vibrations also may occur due to sudden acceleration of the cam surface once they were produced with unsmooth surface. In order to produce highly performance of cam, it has to have a smoothest surface of contact with the follower. This will be a problem for engineer or designers, because they need to reduce sudden acceleration on the surface of the cam.

1.4 PROJECT OBJECTIVES

This project sets a couple of objectives to be covered which are:

i. To derive a parametric equation system for both x and y axis from a relative cam parametric equation of motion.

ii. To simulate a cam profile using parametric equation of motion by programming methods.

1.5 PROJECT SCOPES

The scopes of this project are:

i. Analyze the equation of motion of cam for constant-velocity motion, constant acceleration motion, and simple harmonics motion and cyclodial motion.

ii. Express and perform differential equation to basic cam parametric equations. Perform derivation analysis on the equations of motions to get parametric equation system of x and y axis.

iii. Apply the parametric equation in a source code for C++ programming to produce a cam profiles.

iv. Compare the results between cam profiles from graphical results and programming results

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the details and the basic knowledge about the concept and mechanism of a cam profile will be explained. The contains and information of this chapter are mainly come from reference books, journals, thesis, and shared views from online resources which will be included in references section. In this particular section, relevance knowledge concern about cam mechanism and its cam-follower system will be discussed.

On the further part of this chapter, mostly every part concerning cam mechanism will be thoroughly explained such as types of cam and follower, cam nomenclature, and different type of cam motion. Moreover, important aspects also will be covered such as cam parametric equation, and cam coordinate systems. The whole view of this chapter is to provide a well, better and clearer understanding of the purpose of this project.

2.2 CAM DEFINITION

Cams are used to convert rotary motion into reciprocating motion. The motion created can be simple and regular or complex and irregular. As the cam turns, it driven by the circular motion that gives a predetermined specified motion to the follower. The cam follower traces the surface of the cam transmitting its motion to the required mechanism. A cam mechanism usually consists of two moving elements, the cam and the follower, mounted on a fixed frame. [1]

A cam may be defined as an element of cam-follower mechanical system that compels the movement of the follower by direct contact. The cam has been widely used in variety type of application includes almost all mechanical devices and machinery properties such as in transportation equipment, machine tools, printing process, control systems, food processing machines, automobile internal combustion engines, and even in agriculture. The accuracy of the cam produced is frequently improved and the cost is lowered after each new design are invented or innovated. [2]

2.3 CAM MECHANISMS

We can classify cam mechanisms by the shape of the cam, the series of events of motion, the configuration and arrangement of the follower. Firstly, we can determine cam in terms of their shapes, such as wedge, radial, cylindrical, globoidal or even conical. Also, we cam classify them in terms of the follower motion as the result of direct contact, such as rise-dwell-rise (RDR), dwell-rise-fall-dwell (DRFD) or rise-fall-rise (RFR). Finally, in terms of the follower constraint, this can be achieved by either positive drive or spring load. [3]

2.3.1 Different Types of Cam

There are many different types of cam existed nowadays and each of cam developed have unique way of showing their differences especially in terms of shapes, sizes and also the motion that they produce to the follower. The cam can be design in variety of shapes, and the most popular industrial production cams are [4]:

i. Positive drive – radial groove cam
ii. Radial conjugate dual cam
iii. Cylindrical groove cam
iv. Cylindrical with circumferential contour cut in the end (end cam)

2.3.2 Cam Shape

i. Plate cam (Figure 2.1):

This is the simplest and very common type of cam. It is formed on a disc or a plate. The circumference of the cam varies the radial distance and the center of the disc. The follower will ride on the outer edge and results a radial motion. Thus, this cam can be recognized as radial cam. [5]

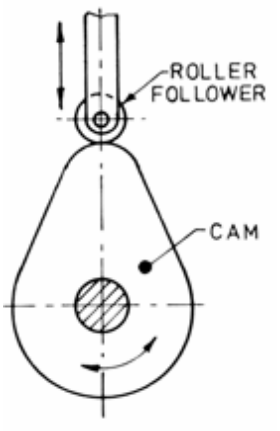

Figure 2.1: Plate cam or disc cam

ii. Grooved cam or closed cam (Figure 2.2):

This cam was basically used in sewing machine. Cutting this cam requires that the cutter be moved in the exact way relative to the spherical cam as the roller follower. [6]

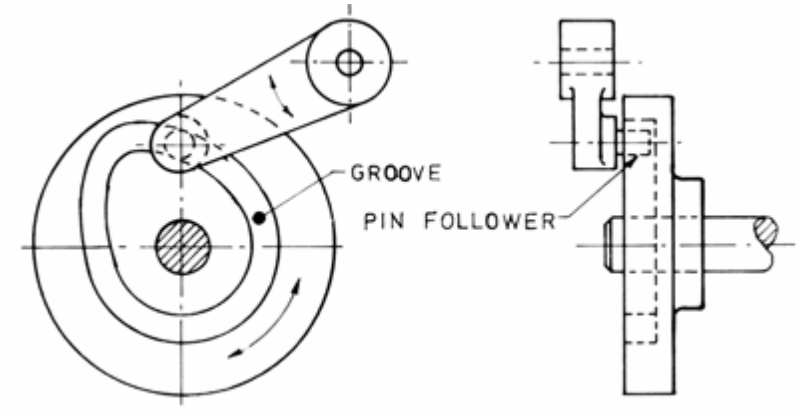

Figure 2.2: Groove cam or closed cam

iii. Cylindrical cam (Figure 2.3):

This important criterion is that this cam is formed on a cylinder. A groove is cut on the cylinder and varies for each axis of rotation. This is to give the follower motion along the axis of rotation. [7]

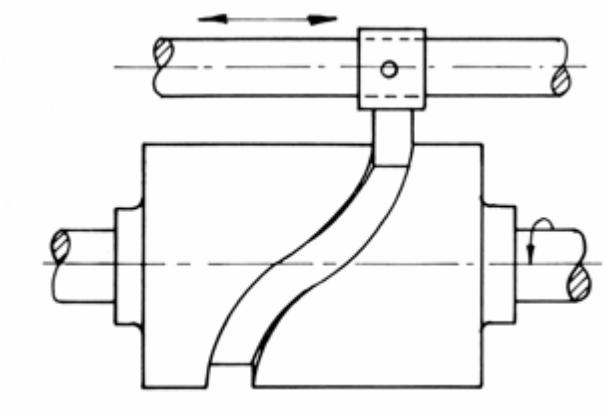

Figure 2.3: Cylindrical cam or barrel cam

iv. End cam (Figure 2.4):

Similar with cylinder cam but the follower contact with the cam on different periphery. The cam rotates, while the follower will translates or oscillates. [8]

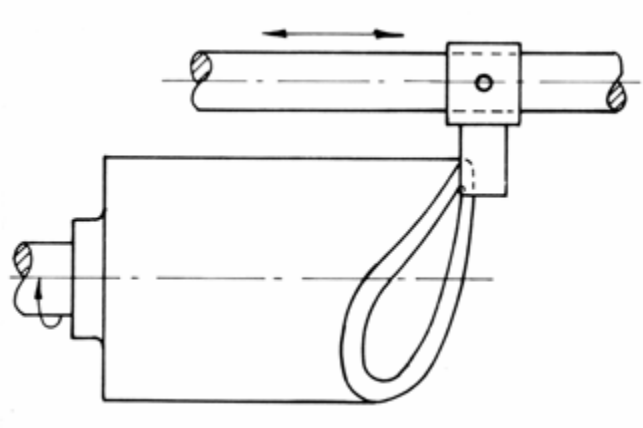

Figure 2.4: End cam

v. Wedge or flat cam (Figure 2.5)

A wedge cam has a wedge in general which has translational motion .The follower can either translate or oscillate. A spring is used to maintain contact between the cam and follower. Instead of wedge a flat plate with a groove is also used.

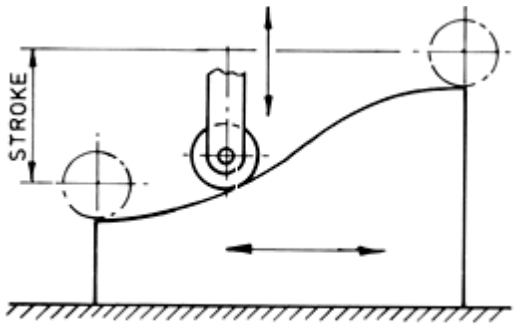

Figure 2.5: Wedge cam

vi. Spiral cam (Figure 2.6)

A spiral cam is a face cam in which a groove is cut in form of spiral. The spiral grooves consist of teeth, which mesh with a pin gear follower. The velocity of the follower is proportional to the radial distance of groove from axis of cam.

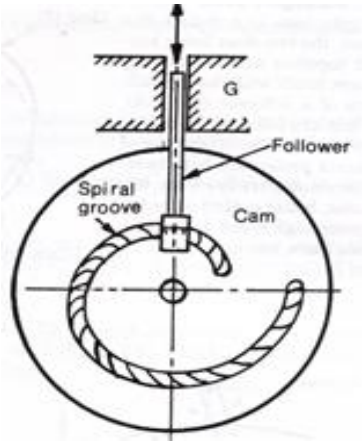

Figure 2.6: Spiral cam

vii. Conjugate cam (Figure 2.7)

A conjugate cam is a double disc cam, two discs being keyed together and is in constant touch with two rollers of the follower.

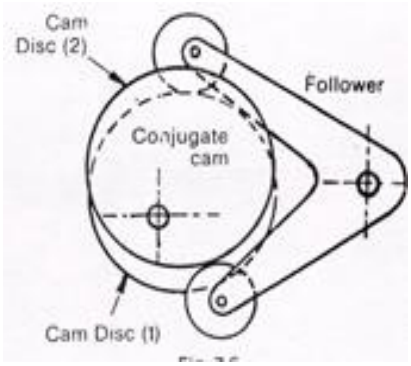

Figure 2.7: Conjugate cam